ET43

ELECTRICAL WORKERS
REGISTRATION BOARD
Safety • Competency

Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

17 November 2012

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

(a) When the load on a transformer changes from no-load to full-load, there is a voltage drop at the secondary terminals.

State **ONE** reason why this voltage drop occurs.

(2 marks)

(b) A 230V, plug-in heater has an output of 2kW. The supply voltage to the heater fluctuates between 230V to 240V.

Describe the effect this voltage fluctuation has on the power output of the heater elements.

(2 marks)

(c) State the **main** reason why effectively earthing the metal frame of a Class I electrical appliance prevents electric shock hazards under fault conditions.

(2 marks)

(turn over)

Question 1 continued

(d) Which of the following methods will change the direction of rotation of a three-phase induction motor?

- Change the control circuit operating voltage from 230V to 400V.
- Change the phase sequence on the incoming supply
- Reverse the polarity of one motor winding
- Interchange two phases on the motor terminal block

(2 marks)

(e) State the effect on the operation of a three-phase induction motor if the **load-torque** exceeds the **pull-out torque**.

(2 marks)

(f) State the **main** reason why an earth fault loop impedance test is carried out at the switchboard of a new electrical installation.

(2 marks)

(turn over)

Question 1 continued

(g) State the **main** reason why an earth fault loop impedance test is carried out at the socket outlet furtherest from switchboard of a new electrical installation.

(2 marks)

(h) Every electrical installation has a prospective-short-circuit current rating.

State **ONE** reason why it is important to consider the prospective-short-circuit current rating when selecting a protective device for an electrical installation.

(2 marks)

(i) Define the term **inverse time-current characteristic** in relation to gG type HRC fuses.

(2 marks)

(turn over)

Question 1 continued

(j) Fluorescent fittings are installed in final subcircuits across three phases in a factory. One method of reducing the stroboscopic effect of the fluorescent fittings is to connect fittings on different phases.

State **TWO** other methods of reducing the stroboscopic effect of the fluorescent fittings.

(2 marks)

(1) ____

____

(2) ____

____

(turn over)

Question 2

(a) **Introduction**

A conveyer at a metal-crushing plant is driven by a three-phase induction motor controlled by a variable-frequency controller. The two reasons the variable-frequency controller is used are:

- The amount of metal delivered by the conveyer can be varied by varying the speed of the conveyer.
- The amount of metal delivered by the conveyer is constant at a set speed.

Use the information in the introduction to this question to answer parts (a)(i), (a)(ii), (a)(iii) and (a)(iv).

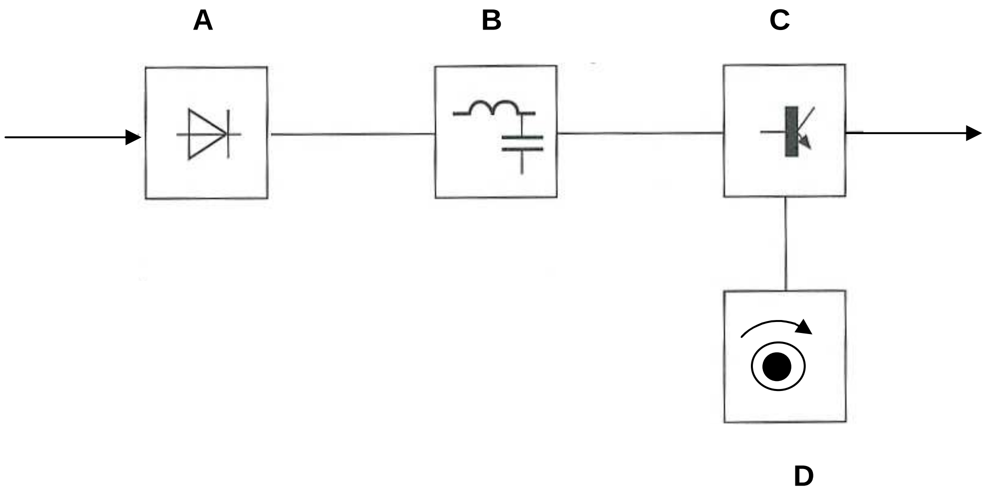
(i) State the **TWO** factors that are varied by a variable-frequency controller to alter the speed of the induction motor.

(1 mark)

(1) ____

(2) ____

(ii) The figure below represents the basic components of the variable-frequency controller



Name the components of the controller.

(2 marks)

(A) ____

(B) ____

(C) ____

(D) ____

(turn over)

Question 2 continued

(iii) In the figure in (a)(ii), what is the purpose of component **C**

(1 mark)

(iv) What would be the effect on the conveyer induction motor if it was operated at a low speed for extended periods?

(1 mark)

(b) State **THREE technical** advantages of an electronic soft starter when compared to an auto-transformer starter when **starting** a three-phase induction motor.

(3 marks)

(1)

(2)

(3)

(c) A three-phase induction motor is started by a star/delta starter. State **ONE** reason why interlocks are used in the starter.

(2 marks)

(turn over)

Question 3

(a) (i) State **TWO** **safety features** the MEN system provides for an electrical installation.

(2 marks)

(1)

(2)

(ii) State **TWO** **potentially hazardous situations** that can occur when the MEN system supplies an electrical installation.

(2 marks)

(1)

(2)

(turn over)

Question 3 continued

(b) What type of switchboard must be **electrically closest** to the point of supply in an MEN electrical installation?

(½ mark)

(c) In the low voltage MEN system the neutral is earthed.

At which points in the low voltage MEN distribution system is the neutral earthed?

(1½marks)

(d) Other than the supply voltage, state **TWO** other factors that determine the level of the prospective short-circuit current in an electrical installation.

(2 marks)

(1)

(2)

(turn over)

Question 3 continued

(e) Explain why **Class II (double-insulated)** electrical equipment **is not** required to be connected to a protective earthing conductor.

(2 marks)

____

____

____

____

(turn over)

Question 4

(a) Figure B shows an **existing** motor control circuit.

Figure A is a **new** remote start-stop station and local stop station.

Connect the **new** remote start-stop station and the local stop station to the **existing** motor control circuit by:

- Removing one conductor from the **existing** motor control circuit. Show the removed conductor like this: ~~XXXX~~
- Use **three** conductors to connect the new remote start-stop station and local stop station to the **existing** motor control circuit.

(2 marks)

Figure A

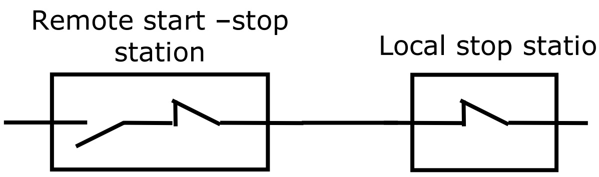
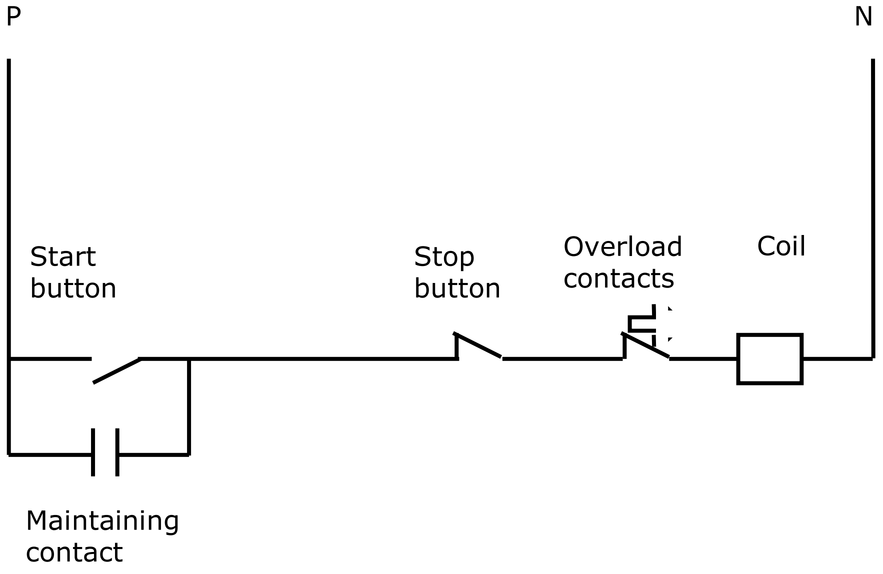


Figure B



(b) A three-phase induction motor is controlled by a star/delta starter.

State what would occur if the main contactor engaged, but the star contactor **did not** engage, and the timer eventually engaged the delta contactor.

(2 marks)

(turn over)

Question 4 continued

(c) **Introduction**

A three-phase induction motor is connected to the supply. The motor technical data is:

Supply voltage	400V
Frequency	50 Hz
Efficiency	84% (fully loaded)
Input power	9.52 kW
Line current	16.96A

Use the information in the introduction to this question to answer parts (c)(i), (c)(ii) and (c)(iii)

(i) Calculate the **output power** of the motor

(2 marks)

(ii) Calculate the **power factor** of the motor

(2 marks)

(turn over)

Question 4 continued

(iii) Calculate the **input kVA** of the motor

(2 marks)

(turn over)

Question 5

Introduction

In an office, a 40A, RCCB and 20A, MCB protect a 230V **final sub-circuit** consisting of:

- 6 double socket outlets supplying various electrical appliances.
- 2 **fixed-wired electrical appliances**.

The MCB has tripped. All the **plug-in** electrical appliances were disconnected.

When the MCB is reset, it trips again when the supply is restored to the final subcircuit.

The MCB is not faulty and is correctly rated for the circuit. Overloading is not an issue.

Use the information in the introduction to answer parts 5(a) and 5(b).

(turn over)

Question 5 continued

(a) If the fault was located in a fixed wired appliance, what procedure would you use to determine that this is where the fault is?

The test instrument to be used is a multi-function test instrument with insulation resistance (with 500V and 250V ranges), resistance, voltage and temperature functions.

Include in your procedure:

- The action taken before the testing
- The function and range selected on the test instrument
- How the testing is carried out
- The test result when the expected fault is found

(5 marks)

(turn over)

Question 5 continued

(b) You have found that the fault **was not** located in a fixed wired appliance. What procedure would you use to determine that the fault is in the final subcircuit?

The test instrument to be used is a multi-function test instrument with insulation resistance (with 500V and 250V ranges), resistance, voltage and temperature functions.

Include in your procedure:

- The action taken before the testing
- The function and range selected on the test instrument
- How the testing is carried out
- The test result when the expected fault is found

(5 marks)

(turn over)

Question 6

Introduction

An electrician has repaired a 400V, three-phase induction motor in a workshop.

You are required to connect a new four-core flexible cord to the motor and then reconnect it to an existing DOL starter.

A lockable isolator is located adjacent to the DOL starter. There are no danger tags or locks attached to the isolator.

Use the information in the introduction to this question to answer parts 6(a), 6(b) and 6(c).

(a) **TWO** tests using test instruments need to be carried out on the flexible cord and motor to ensure they are safe to connect to the DOL starter.

(i) State the order in which the tests are carried out.

(1 mark)

(ii) For **ONE** of the tests state:

- The type of instrument used
- The test voltage (if applicable)
- How the test is carried out
- A test result that will permit the motor to be reconnected

(3 marks)

(turn over)

Question 6 continued

(b) State the sequence of actions you must take **before** connecting the cord to the DOL starter **to ensure your own safety**.

(3 marks)

(turn over)

Question 6 continued

(c) You have connected the motor flexible cord to the DOL starter, but have not livened the starter.

Describe the testing you need to carry out to ensure that in the event of a fault developing on the motor, the motor electrical protection will operate.

Include in your description:

- The type of instrument used
- How the test is carried out
- A test result that will permit the motor to be livened

(3 marks)

(turn over)

Question 7

Introduction

A new factory has been constructed that incorporates some imported machinery that operates at a voltage other than standard low voltage. A dedicated supply is required for this machinery.

A 150 kVA, three-phase, delta-star transformer will be used. The characteristics of the transformer are:

- A turns ratio of 43.3 to 1
- A primary voltage of 11 kV

Use the information in the introduction to this question to answer parts 7(a), 7(b), 7(c), 7(d) and 7(e).

(a) Calculate the **secondary phase** voltage.

(2 marks)

(b) Calculate the **secondary line** voltage.

(2 marks)

(turn over)

Question 7 continued

(c) Calculate the **primary line** current.

(2 marks)

(d) Calculate the **maximum secondary line current** the transformer can deliver under full load conditions.

(2 marks)

(e) State the form of cooling that would be used for the 150 kVA transformer.

(2 marks)

(turn over)

Question 8

(a) (i) Draw and label a circuit diagram for a half-controlled, single-phase, full wave bridge rectifier supplying a resistive load.

Include in your diagram the following components:

- Single-phase transformer
- SCRs
- Diodes
- Load
- Control circuit (block only)

(5 marks)

(ii) Draw and label the output waveform at half output (90^0).

(2 marks)

(turn over)

Question 8 continued

(b) State **ONE** component that may be used as part of a circuit to filter a rectifier output.

(1 mark)

(c) State **ONE** factor that will cause an SCR to be turned off once it has been triggered (turned on).

(2 marks)

(turn over)

Question 9

(a) Danger tags and out-of-service tags are designed to promote safety in the workplace.

(i) Describe the circumstances when a **danger tag** is used.

(1 mark)

(ii) Describe the circumstances when an **out-of-service tag** is used.

(1 mark)

(iii) List **TWO** precautions to be taken when attaching a danger tag to an isolating switch.

(2 marks)

(1)

(2)

(turn over)

Question 9 continued

(b) Explain the difference between:

- A 10 kW pump motor that has been **isolated**.

and

- A 10 kW pump motor that has been **switched off**.

(3 marks)

(c) Describe how the **prove-test-prove** method is carried out for the testing for voltage to ensure isolation.

(1½ marks)

(turn over)

Question 9 continued

(d) You are testing for voltage at the supply side of a three-phase main switch to see if the switchboard is isolated.

What tests would you make to **clearly establish** that isolation (or otherwise) has taken place.

(1 mark)

(e) State the main reason why a resistor would be connected across a circuit after the electricity supply to that circuit has been isolated.

(½ mark)

For Candidate’s Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

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Questions Answered	**Marks**	
1		
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